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REVISED SHIP POSITIONING
AND COVERAGE DATA
FOR MISSION APOLLO 8
LUNAR LAUNCH OPPORTUNITIES
FOR DECEMBER 1968

TRW Systems Group

MISSION PLANNING AND ANALYSIS DIVISION



MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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PROJECT APOLLO

REVISED SHIP POSITIONING AND COVERAGE DATA
FOR MISSION APOLLO 8 LUNAR LAUNCH OPPORTUNITIES
FOR DECEMBER 1968

By M. B. Vick, TRW Systems Group

MSC Task Monitor: H. D. Beck

December 16, 1968

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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REVISED SHIP POSITIONING AND COVERAGE DATA FOR MISSION APOLLO 8
LUNAR LAUNCH OPPORTUNITIES FOR DECEMBER 1968

By M. B. Vick

1. INTRODUCTION AND SUMMARY

Revised injection ship positioning and coverage data are presented for Mission Apollo 8 launch opportunities occurring during December 1968. The injection ships are positioned to provide coverage from TLI minus two minutes to TLI ignition. Revised reentry ship positioning data are also presented. The reentry ship is positioned to provide additional coverage of the translunar injection (TLI) burn. These data were determined using the visual technique presented in Reference 1, and verified using the radar ship tracking program described in Reference 2. The positions of the TLI maneuvers were obtained from Volume III of the Spacecraft Operational Trajectory, Reference 3. The revised ship positions supersede the positions presented in "Mission C'-Alternate 1 Ship Positioning and Coverage Data for Lunar Launch Opportunities for December 1968," TRW Report 3421.6-148, 15 November 1968.

Launch days specified for analysis were the 21st through the 27th of December. Coverage was examined for all launch azimuths from 72 through 108 degrees except in those instances when the daylight launch requirement was not satisfied. The coverage was determined for both first and second injection opportunities. A plan has been derived that specifies daily ship positions for the entire monthly opportunity. Because the rate of movement of the TLI loci on a day-to-day basis exceeds the movement capability of the ships, the coverage is generally quite good for the first 3 days and is somewhat reduced on succeeding days. Because of land mass interference, the opening of the window is not provided coverage on the 26th and the 27th. Both the Guam and Carnarvon MSFN stations provide supplemental coverage dependent upon the TLI maneuver position. This supplemental coverage is particularly significant during the latter days of the monthly opportunity when Carnarvon provides major assistance.

The coverage provided by the reentry ship is a continuation of the coverage provided by the injection ships or Carnarvon whenever possible. The support positions specified for the reentry ship are such that repositioning to cover the reentry occurring approximately 144 hours later is within the ship's movement capability.

2. SHIP POSITIONING GUIDELINES

The general guidelines established to determine the ship positions and coverage data presented in this report are as follows:

- o Coverage is optimized for the final two minutes of the S-IVB preignition sequence (TLI ignition minus two minutes to TLI ignition).
- o Coverage begins at the opening of the window whenever possible and is continuous across the maximum possible number of launch azimuths.
- o Coverage is maximum for the first injection opportunity.
- o Coverage is provided for the complete 36-degree launch window when possible unless the window is reduced by the daylight launch restrictions.
- o The movement rate of the injection ship Mercury is limited to a speed of advance (SOA) of 12 knots for repositioning on a day-to-day basis.
- o The movement rate of the injection ship Redstone is limited to a SOA of 14 knots for repositioning on a day-to-day basis.
- o The movement rate of the reentry ship Huntsville is limited to a SOA of 14 knots for repositioning on a day-to-day basis.
- o The movement rate of the ships while in restricted waters is limited to a SOA of 10 knots.
- o The support positions for the first and second days of the opportunity may be separated by 21 hours of movement time; however, 25 hours of movement time may separate the support positions for subsequent days.
- o The minimum depth of the water in which the ships are able to maneuver is five fathoms.
- o The minimum antenna elevation angle is assumed to be zero degrees.
- o The reentry ship is positioned to provide TLI maneuver burn coverage for lower launch azimuths.
- o The reentry ship coverage is continuous from acquisition by the injection ships or Carnarvon when possible.

- o The reentry ship must be positioned to be able to return to the entry position for each launch date 144 hours after TLI.

3. RESULTS

The support positions of the ships and the coverage which is provided by the injection ships from TLI minus two minutes to TLI ignition are shown in Tables 1 and 2. The coverage data are shown on bar graphs in terms of the launch azimuths for each launch date. Coverage for the first and second injection opportunities is given and the launch azimuths common to both opportunities for which coverage is provided are identified. Coverage data and the duration of the launch window with the corresponding ship positions for each launch day are presented in tabular form below the bar graphs.

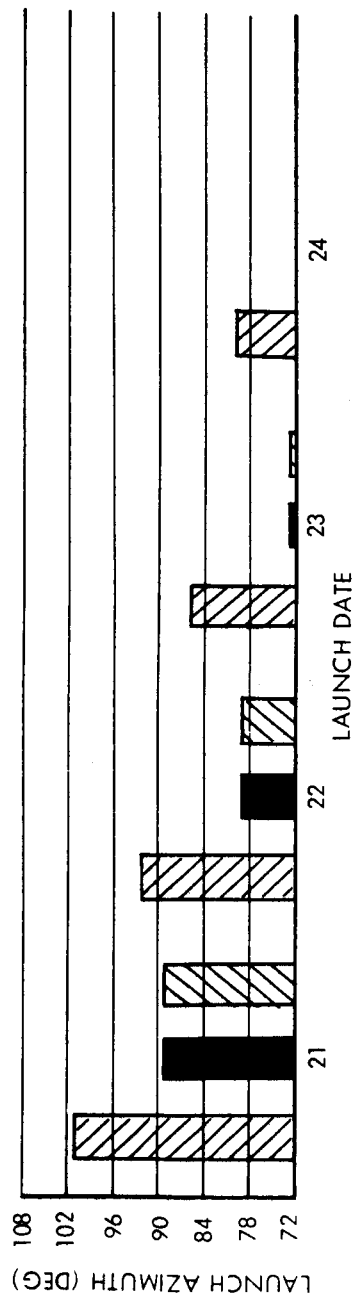
A map showing the December TLI and TLI minus two minute maneuver loci for the first injection opportunity and the locations of the ships on each day is presented in Figure 1. The TLI maneuvers range from about nine degrees north latitude on 21 December to near thirty degrees south latitude on 27 December.

MSFN and injection ship visibility contours are presented in Figure 2. The spacecraft positions at TLI and TLI minus 2 minutes are indicated for both the first and second injection opportunities. Coverage is shown as a function of launch azimuth versus ground elapsed time.

The coverage from the two injection ships is generally good for the first 3 days of the opportunity but begins to decrease thereafter due to the ship movement limitations. The island of New Guinea lies astride the desired movement path of the westernmost ship and is a primary cause of the decreased coverage beginning on the 24th of December. The presence of the Australian land mass prohibits ship placement to cover the opening of the window on the 26th and 27th.

Some support is provided by the Guam MSFN station on the 21st of December. The Carnarvon MSFN station provides assistance on the 25th and all of the coverage on the 26th and 27th.

The duration of the launch window for which coverage of the first injection opportunity is provided ranges from almost four hours on the 21st of December to about 3/4 of an hour on the 25th.

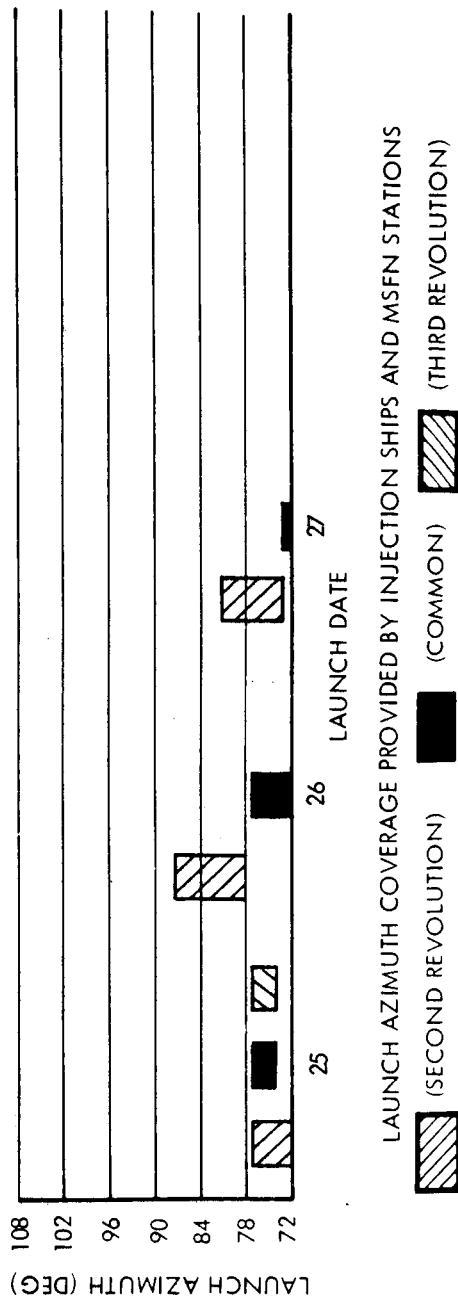


LAUNCH AZIMUTH COVERAGE PROVIDED BY INJECTION SHIPS AND MSFN STATIONS

SHIP POSITIONS

Launch Date	Azimuths Covered (deg)			Launch Window Duration For Azimuths Covered (hr:min)				Injection Ships				Reentry Ship Huntsville	
	Second Rev	Common	Third Rev	Second Rev	Common	Third Rev		Mercury		Redstone		Lat (deg)	Long (deg)
								Lat (deg)	Long (deg)	Lat (deg)	Long (deg)		
21 Dec.	72-101	72-89	72-89	3:45	1:59	1:59		7.5N	178.5W	2.5N	155.5E	25.0N	175.0W
22 Dec.	72-92	72-79	72-79	2:33	0:48	0:48		4.0N	179.2E	2.2S	154.0E	21.0N	173.0W
23 Dec.	72-86	72-73	72-73	1:50	0:07	0:07		2.0N	175.0E	8.0S	154.4E	19.0N	175.0W
24 Dec.	72-80	----	----	1:06	----	----		1.0N	171.0E	13.2S	153.0E	16.0N	177.5W

Table 1. Launch Window and Practical Ship Positions for Tracking Coverage from TLI Ignition Minus 2 Minutes Through TLI Ignition; Mission Opportunities for 21, 22, 23, 24 December 1968



SHIP POSITIONS

Launch Date	Azimuths Covered (deg)	Launch Window Duration For Azimuths Covered (hr:min)			Injection Ships				Reentry Ship		
		Second Rev	Common	Third Rev	Mercury		Redstone		Huntsville		
					Lat (deg)	Long (deg)	Lat (deg)	Long (deg)	Lat (deg)	Long (deg)	
25 Dec.	72-77	74-77	0:44	0:27	0:27	2.5S	167.5E	15.5S	147.5E	13.5N	178.0W
26 Dec.	78-87	72-77	1:28	----	0:49	2.5S	167.5E	17.0S	147.0E	13.5N	178.0W
27 Dec.	73-81	72-73	1:29	----	0:11	2.5S	167.5E	17.0S	147.0E	13.5N	178.0W

Table 2. Launch Window and Practical Ship Positions for Tracking Coverage from TLI Ignition Minus 2 Minutes Through TLI Ignition; Mission Opportunities for 25, 26, 27 December 1968

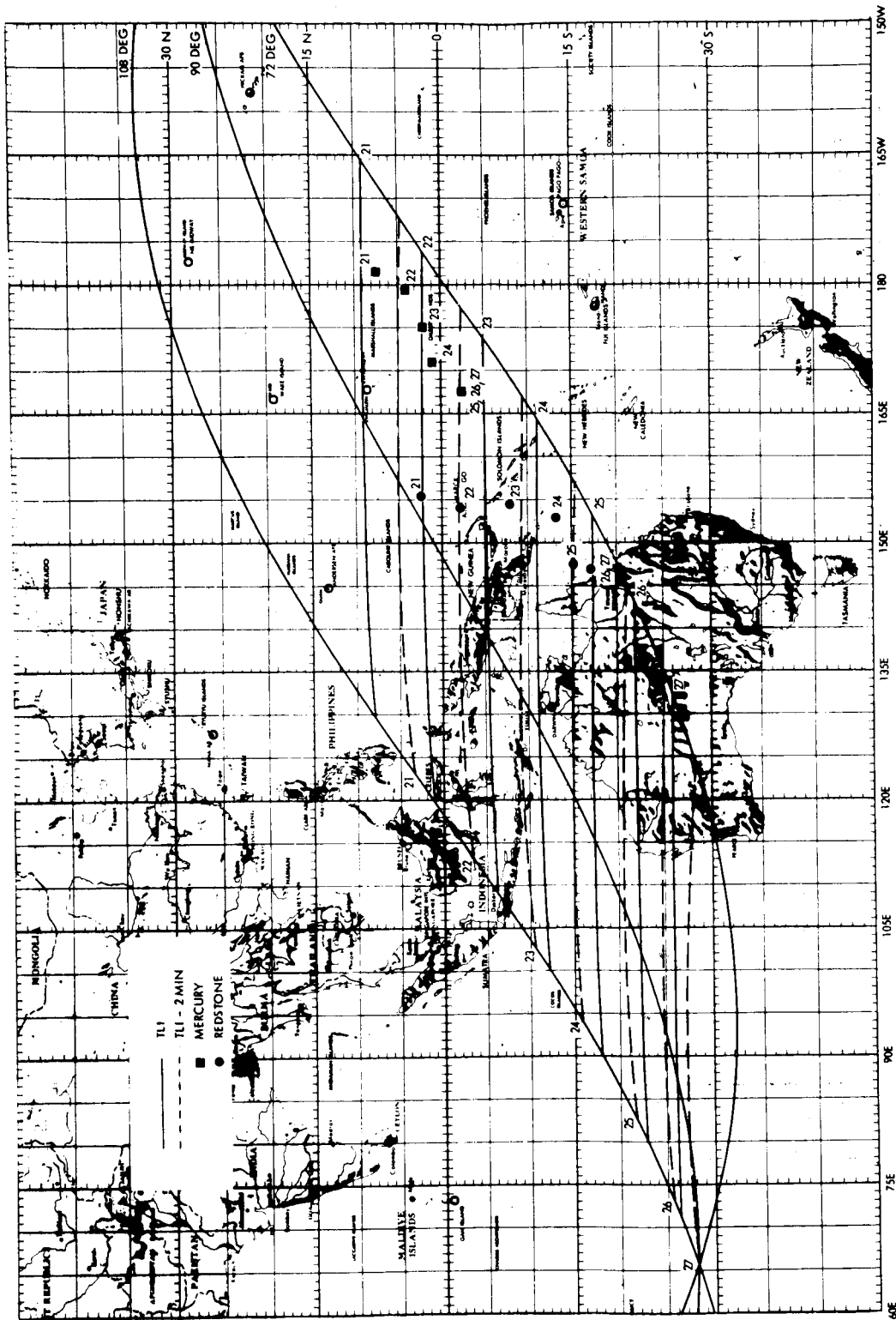


Figure 1. TLI Maneuver Loci and Practical Ship Positions for Tracking Coverage from TLI Ignition Minus 2 Minutes Through TLI Ignition for Day-to-Day Ship Repositioning Criteria: Mission Opportunities for 21-27 December 1968

Figure 2a. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation, 21 December 1968



Figure 2c. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation, 23 December 1968

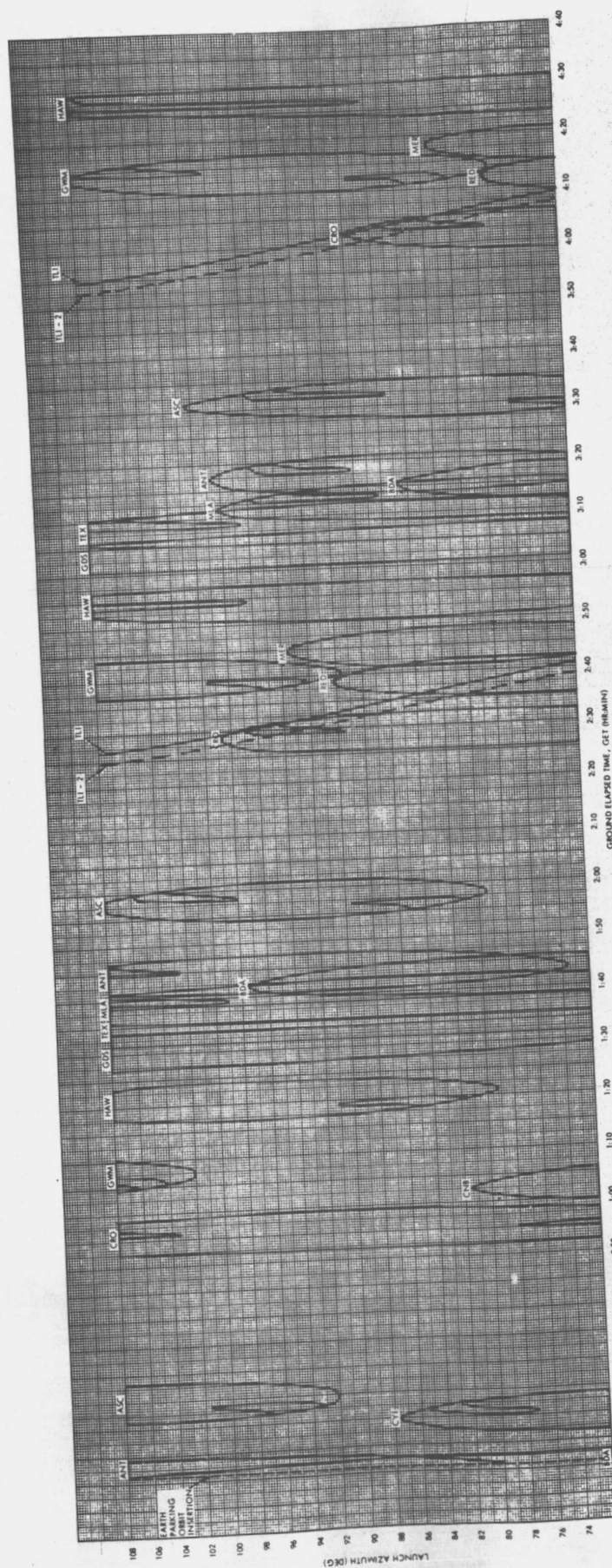


Figure 2d. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation, 24 December 1968

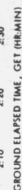


Figure 2e. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation, 25 December 1968

Figure 2f. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation, 26 December 1968



Figure 2g. MSFN and Injection Ship Visibility Contours, 0-degree Antenna Elevation. 27 December 1968

4. REFERENCES

1. R. E. Dawley, "Injection Ship Positioning Technique for Apollo Lunar Missions," TRW Note 67-FMT-523, 23 June 1967.
2. C. E. Harrison and J. R. White, "Preliminary Radar Ship Analysis Program," TRW Note 67-FMT-554, 3 November 1967.
3. "Apollo Mission C' Spacecraft Operational Trajectory, Alternate 1, Lunar Orbital Mission," Volume III, MSC Note 68-FM-524, 16 October 1968.
4. "Mission C'-Alternate 1 Ship Positioning and Coverage Data for Lunar Launch Opportunities for December 1968," TRW Report 3421.6-148, 15 November 1968.
5. "Task Agreement for Mission Analysis Support for the Detailed Design of Lunar Missions," MSC/TRW Task A-134, Amendment No. 6, 1 December 1968.